Choice of flexibility sources towards a 100% renewable based Nordic energy system

Skytte, Klaus

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Flex4RES
Flexible Nordic Energy Systems

DTU

Choice of Flexibility sources towards a 100% renewable based Nordic energy system

System Resiliency and Flexibility
IEA EGRD
Vienna, May 2019

project coordinator:

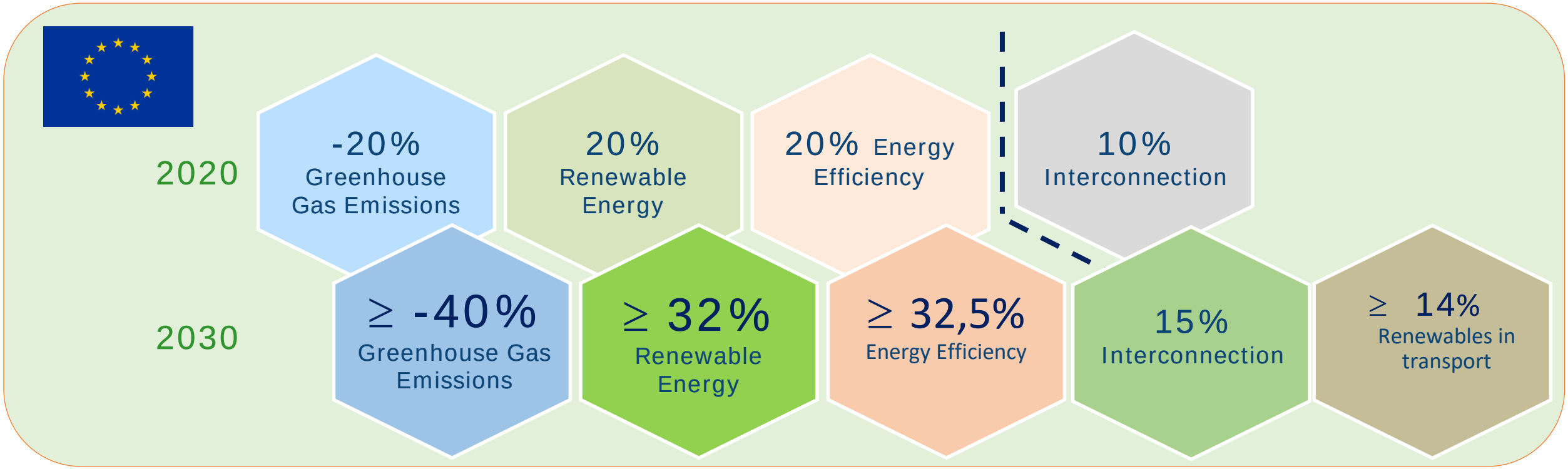
Klaus Skytte Klsk@dtu.dk

Energy Economics and Regulation
DTU, Department of Technology, Management and Economics,
Denmark

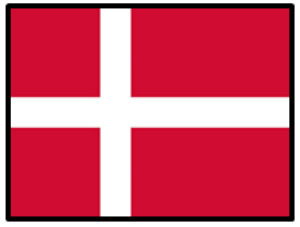
Nordic Energy Research

Towards 100% RES and Carbon Neutrality

Flex4RES



Nordic long-term decarbonisation targets

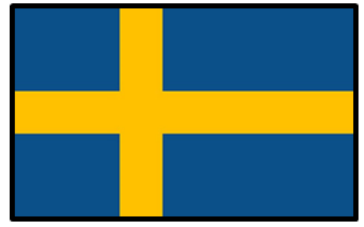


Independent of fossil fuels 2050

≥ - 80 % Greenhouse Gas Emissions 2050

≥ - 50-75% Greenhouse Gas Emissions 2050

Carbon neutral 2050



No net greenhouse gas emissions 2045

The Clean Energy Transition

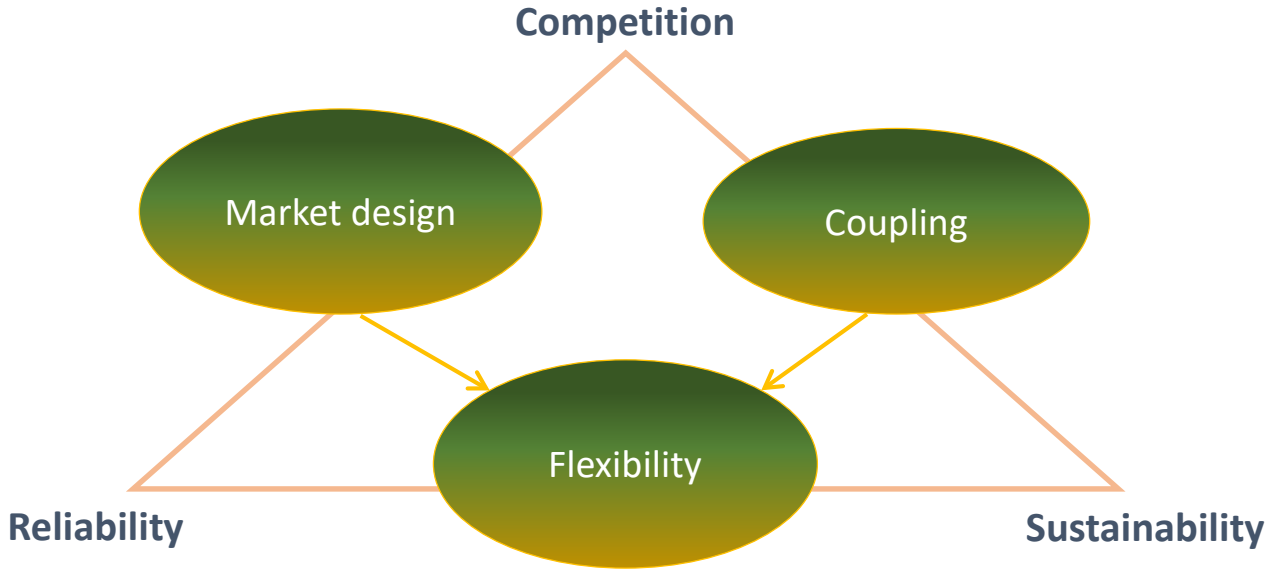
Goals and RE-thinking of the energy infrastructure

Flex4RES

Current electricity system → The trichotomy of energy policy → Decarbonised energy systems

Centralised fossil-intensive supply

Electricity market only

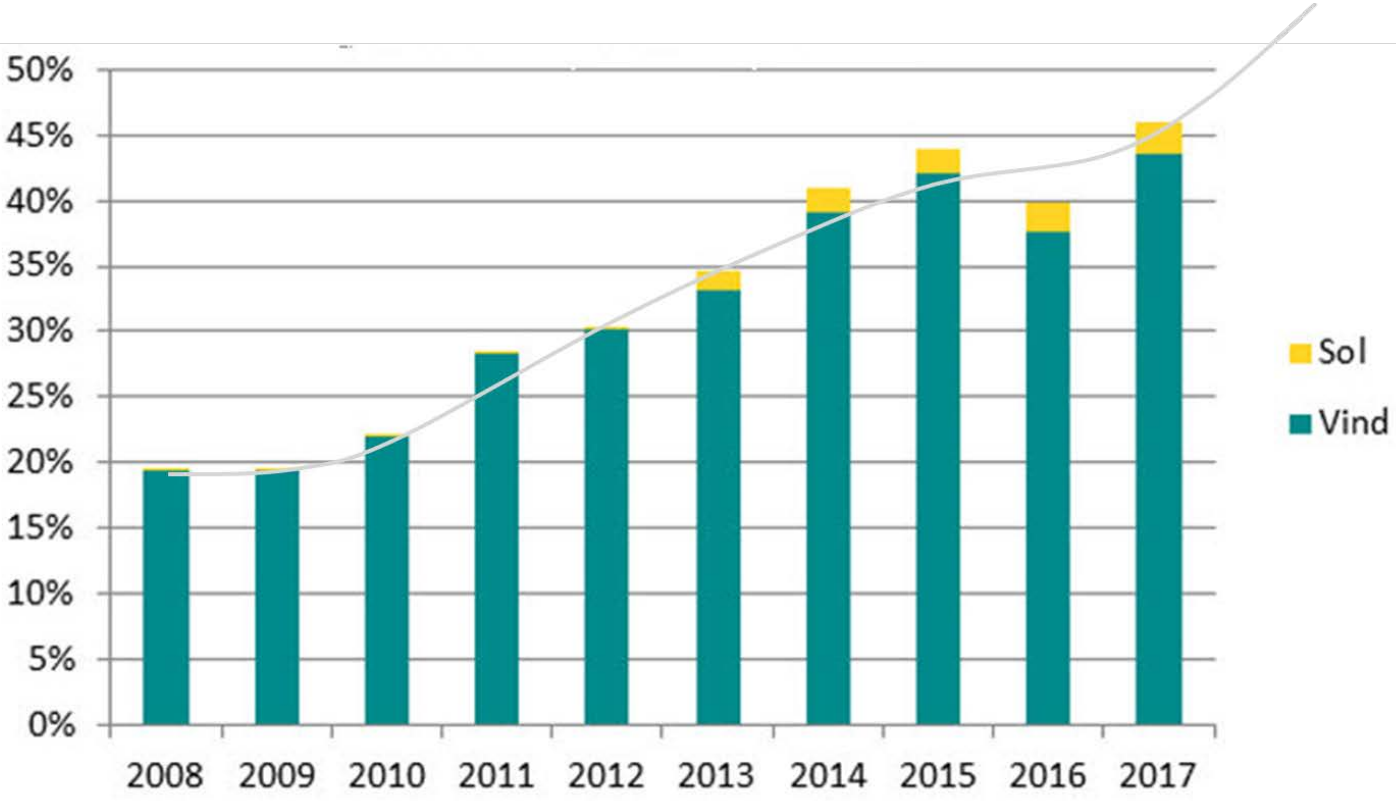


Decentralised
+
Variable renewable energy
+
Phase-out of fossil peakers

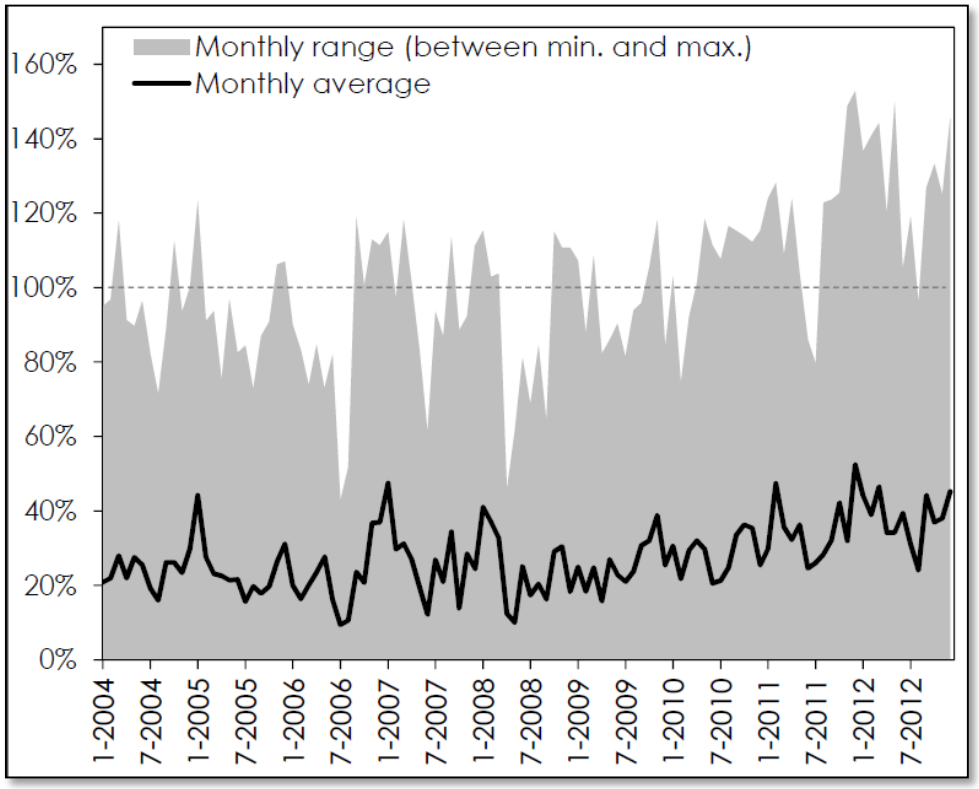
System integration

Example: Wind share in Denmark

Flex4RES



Wind production share in DK-West



23 December 2017: 1 hour with 139%
25 December 2017: 1 day with average of 109%

Political target 2050:
The total energy supply based on renewable energy
incl. heat, gas, transport, industry, etc.

Need for Flexibility

Present Flexibility

Flex4RES

Adequate Flexibility Indicator

AFI = 1/(1+CV[*p*])

where

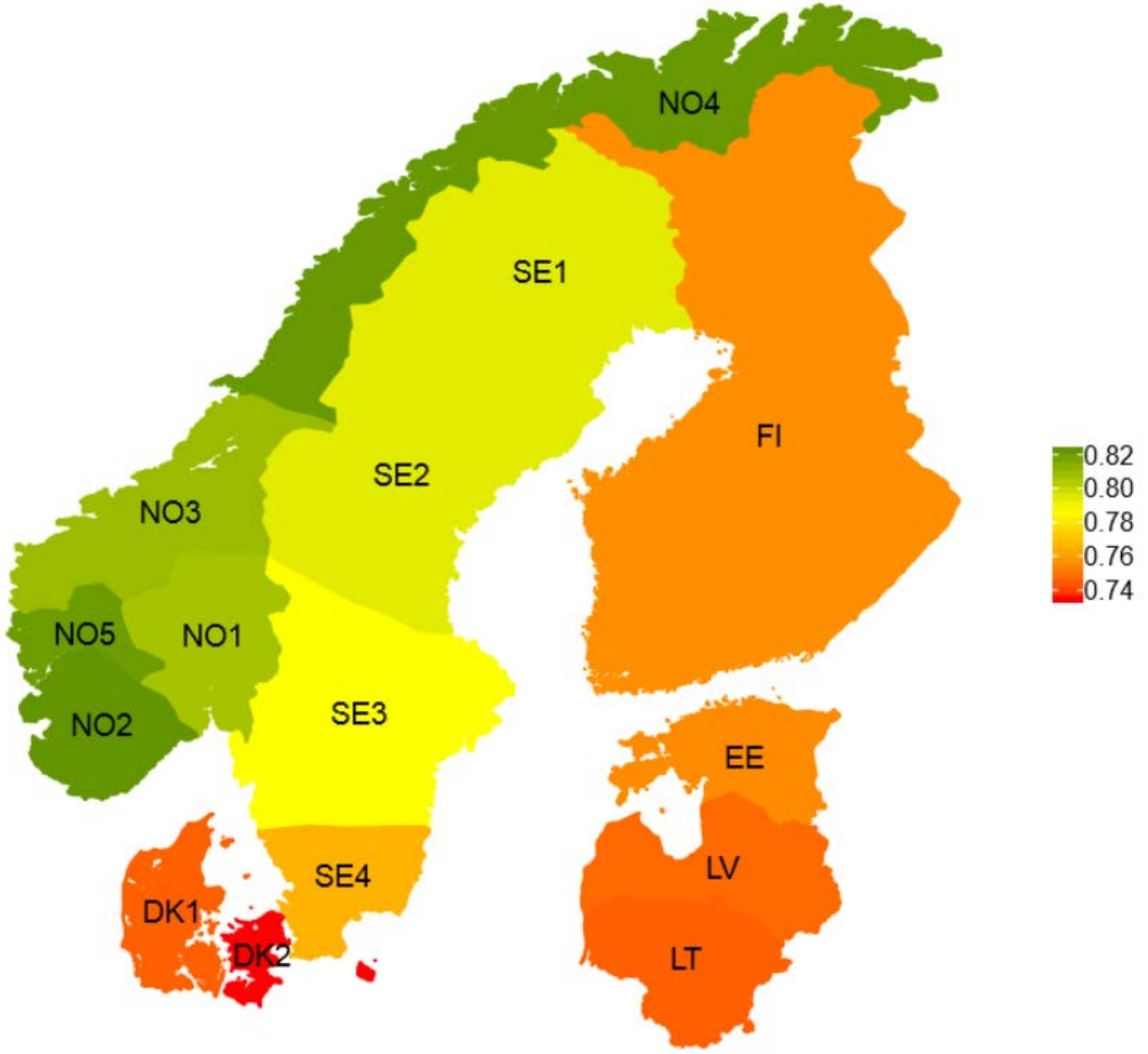
CV[*p*] = sigma[*p*]/E[*p*]
is the coefficient of variation of prices

AFI between 0 and 1

0 = no flexibility; infinitely volatile prices

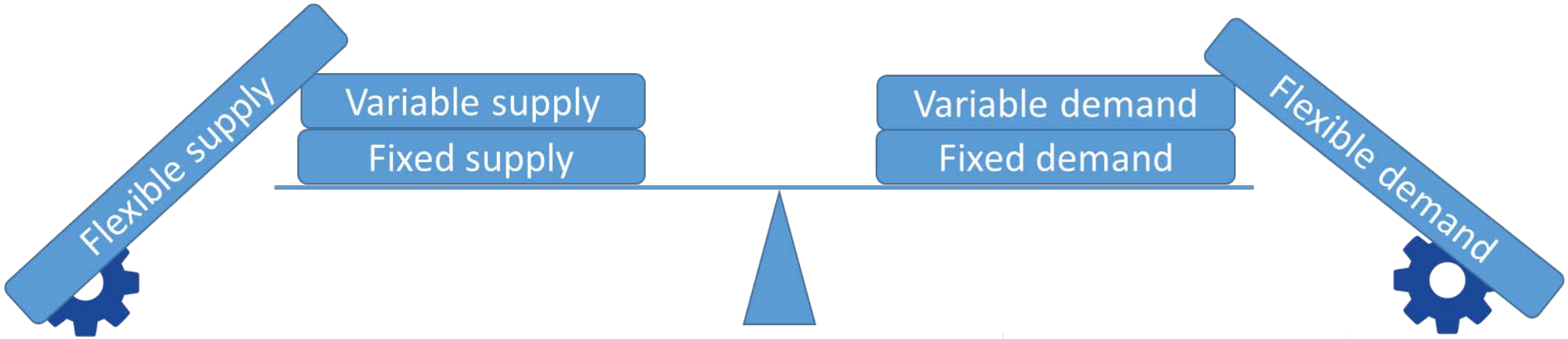
1 = perfectly adequate flexibility; constant prices

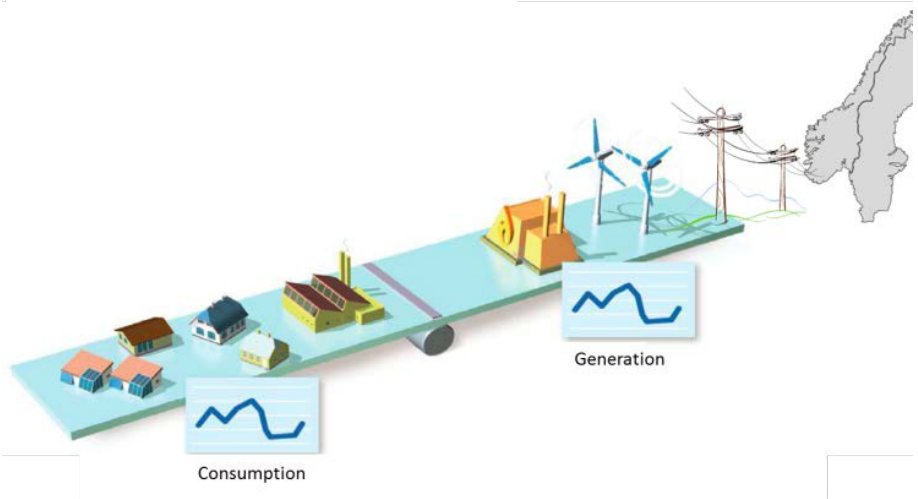
Nord Pool market prices 2018



Flexibility definition

Flex4RES

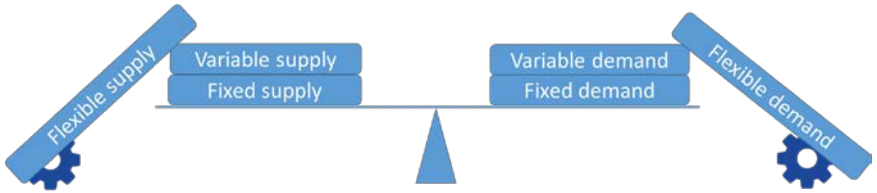




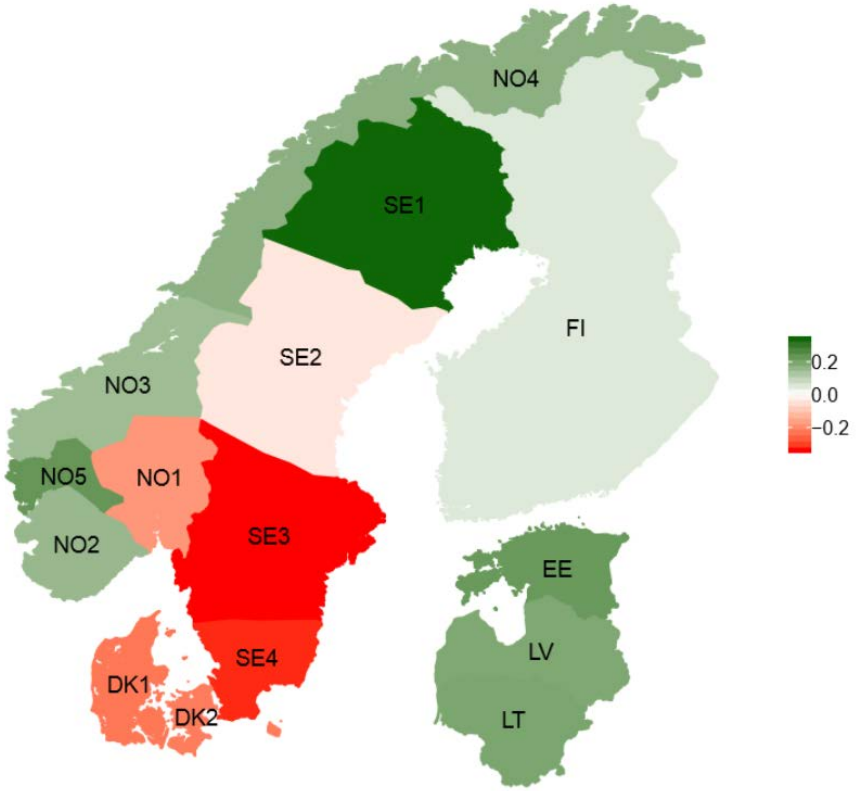
Supply and demand flexibility

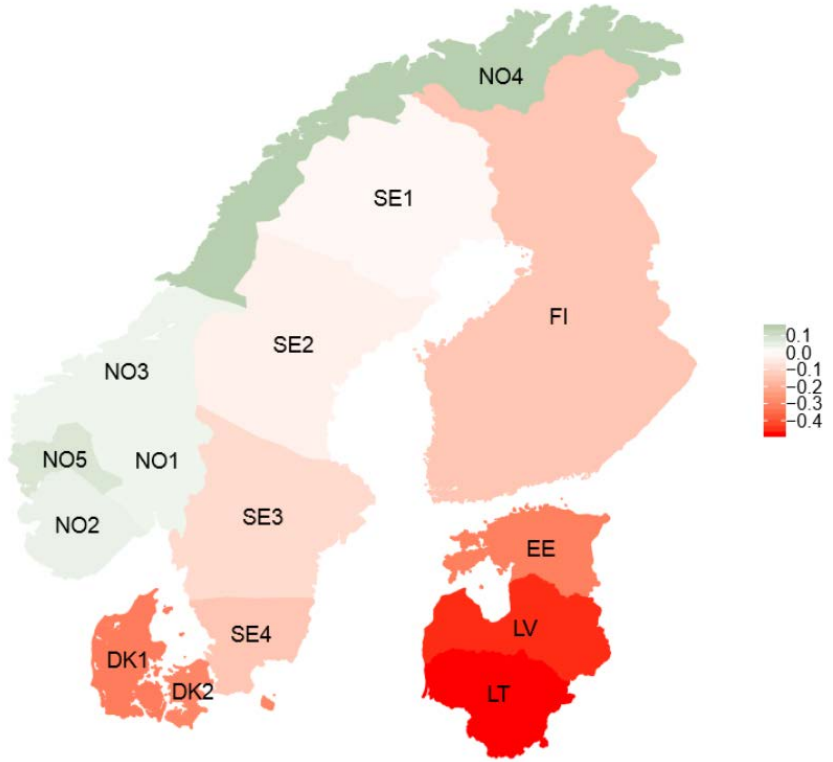
Flex4RES

Supply side
Corr[Prod; *p*]



Demand side
-Corr[Cons; *p*]





Nord Pool data 2018

Negative values indicate large influence of variable supply

Negative values indicate large influence of variable demand

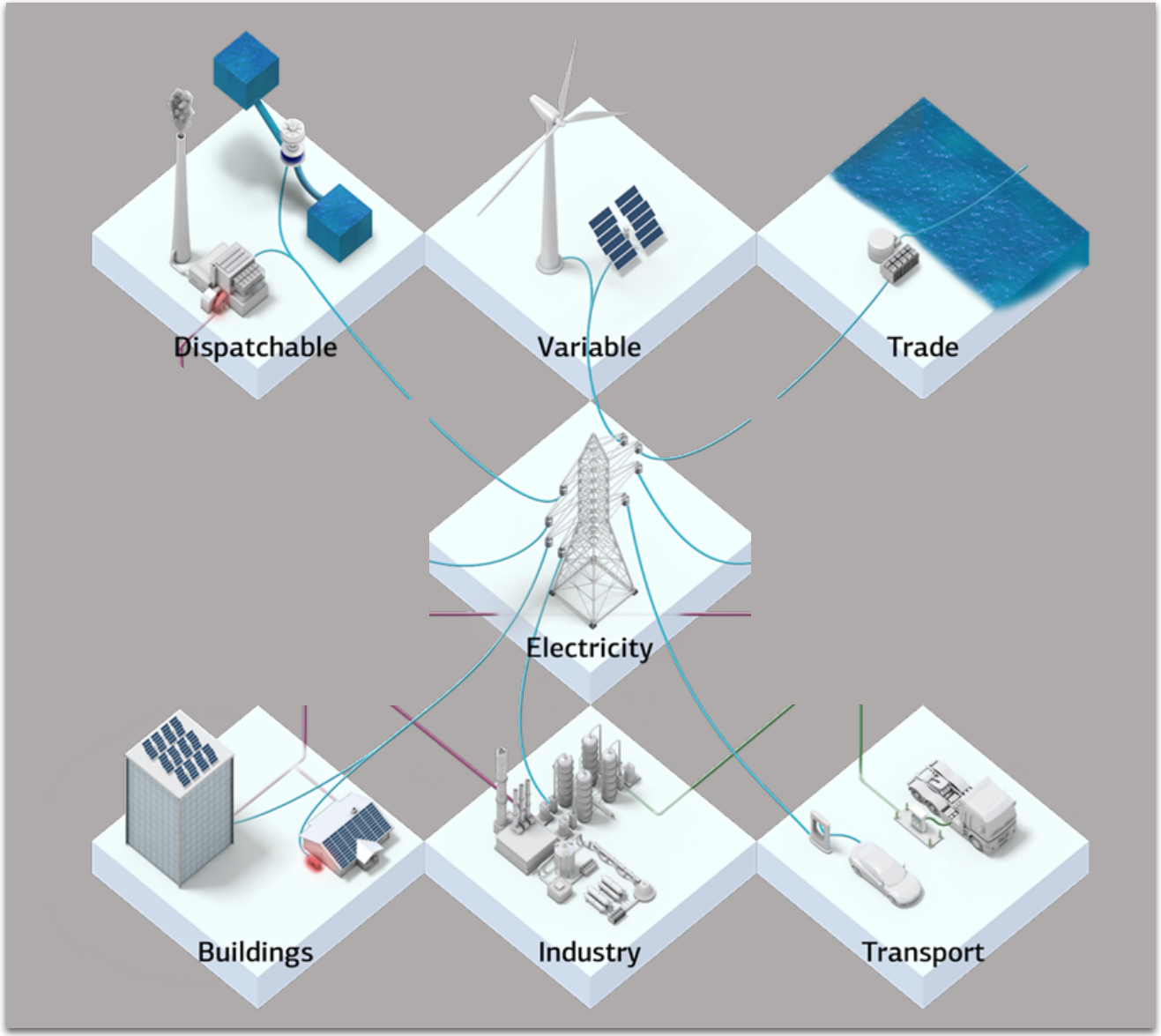
Flexibility in electricity infrastructures

Flex4RES

Resource

System

Service



Supply flexibility

Demand responds

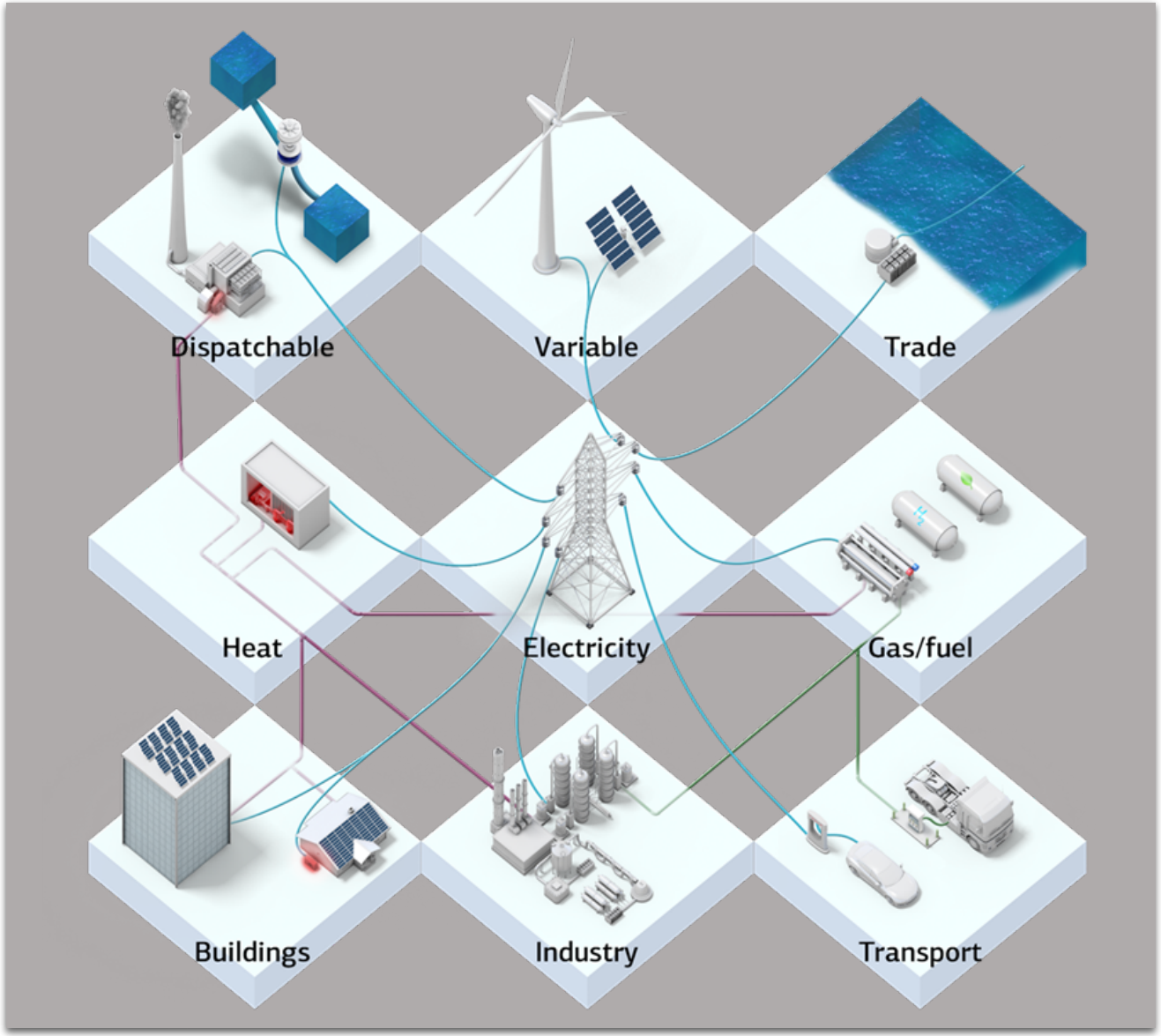
Flexibility in coupled infrastructures

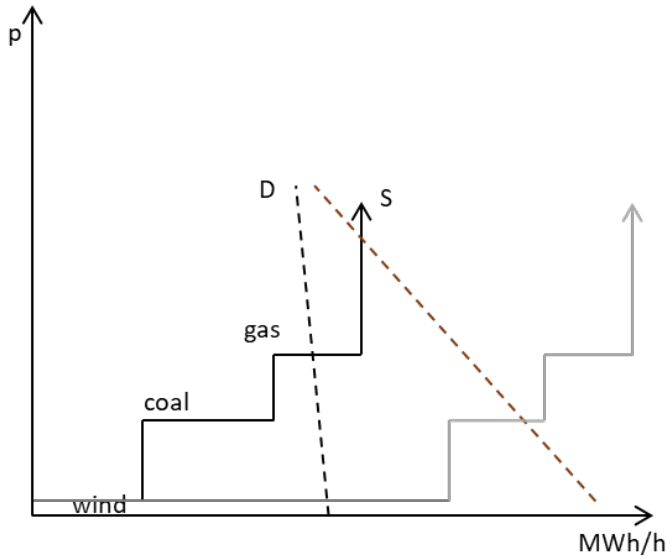
Flex4RES

Resource

System

Service





Sector coupling/
Electrification

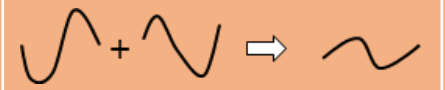
Demand responds

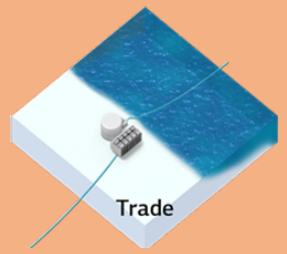
Flexibility by coupling

Flex4RES

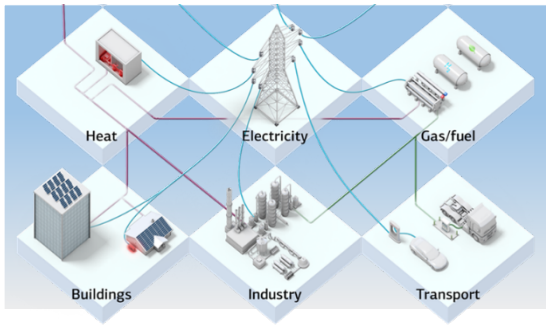
Transmission

Electricity/gas/heat
Transport/storage

Coupling	Incentives for flexibility	Price variations	Driver	Impact
Geographical coupling	Price differences between regions		Different technology mix	Increased imports and exports
Sector coupling	Price differences between energy sources and technologies		Increased business opportunities	Increased national demand



Interconnection
Common frameworks developed over the last 3 decades

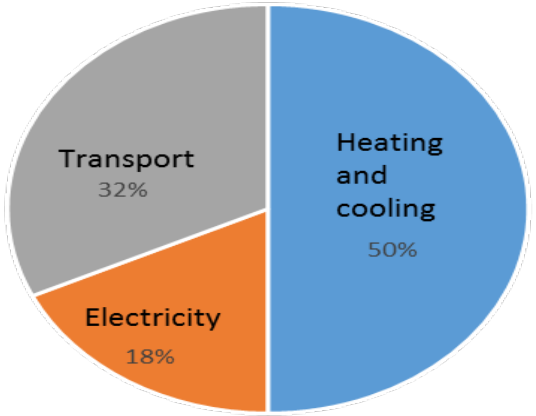


Sector coupling
Sector specific frameworks

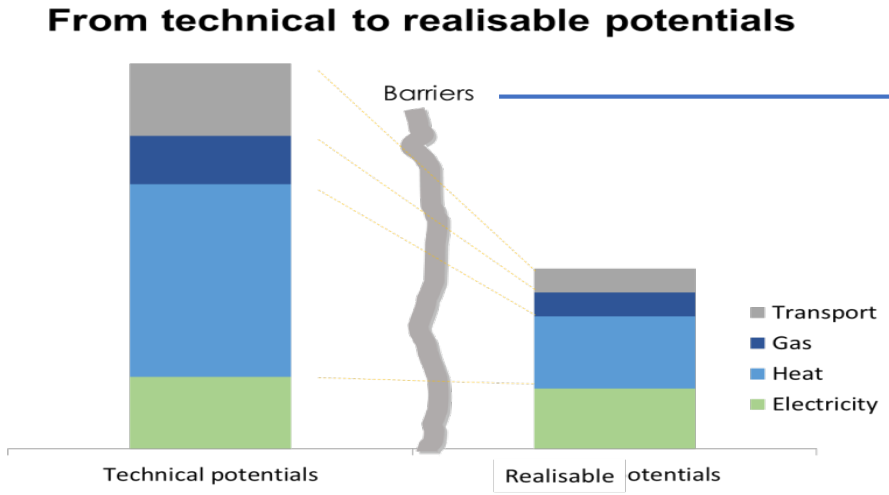
Sector coupling

Electrification as source of flexibility

Flex4RES



Distribution of EU energy consumption
(Source: EU Heating and Cooling strategy)



Nordic/Baltic interview survey

Framework conditions

- Market design
- Direct regulation
- Fiscal policies
- Support schemes
- Grid regulation

Large flexibility potentials in electrification of the energy sectors → Hindered by regulatory barriers → Remove barriers

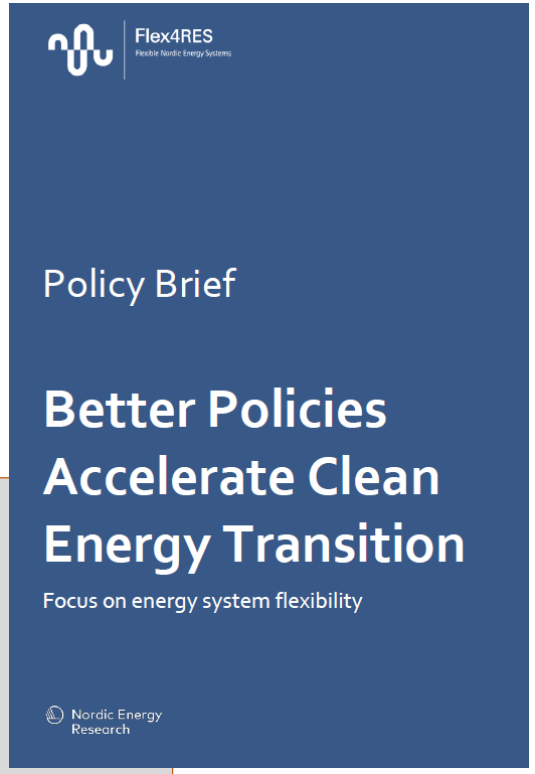
Nordic Barriers

- EU framework (Clean Energy for All Europeans)
- Nordic region greener than EU
- Traditional energy policy framework still dominate

Main barriers

B1 Insufficient market signals for some stakeholders;

B2 Uneven frameworks for different renewable energy resources.



Policy recommendations (Market-based policy framework)**:**

R1 **Create a level playing field** for all RES technologies across sectors through consistent fiscal policies;

R2 Implement electricity **grid tariffs** which allow market signals for flexibility to reach the end-users;

R3 **Dynamic taxation** of electricity (e.g. restructuring levies and taxes);

R4 Encourage **VRE operators to act flexibly** using short-term market-based incentives;

R5 Abolish RES support during negative price periods;

R6 Enhance electrification by removing the limitations on using electricity for heating;

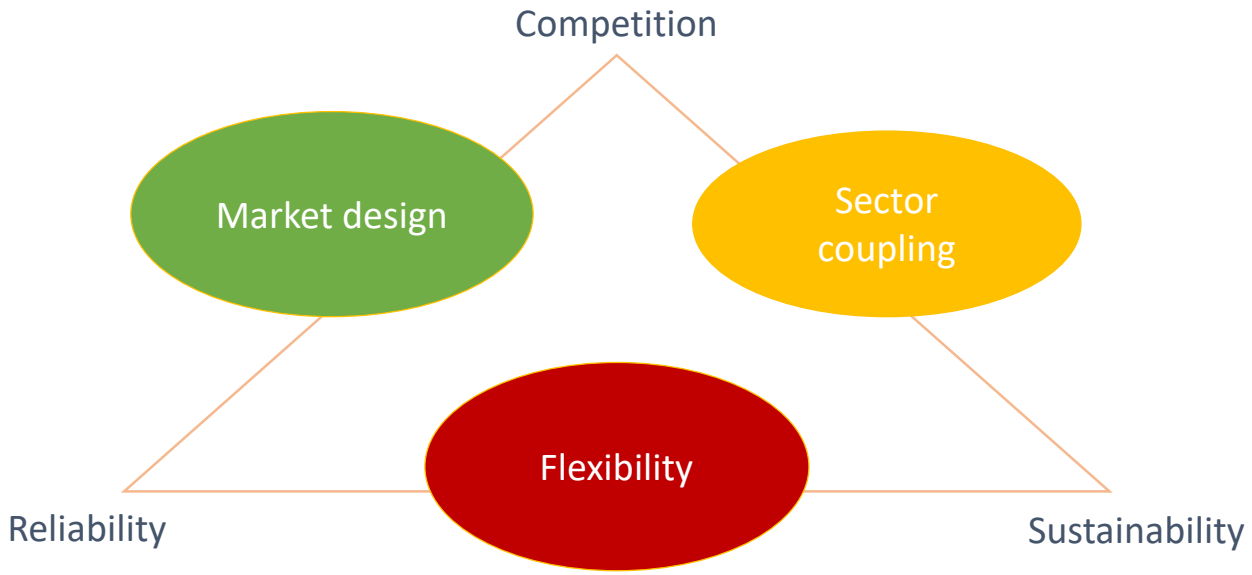
R7 Tackle investment risks in flexible individual heating through new financing and private ownership models.

Nordic commonalities with regional diversity

Recommendations	Related barrier(s)	Denmark	Norway	Sweden	Finland	Estonia	Latvia	Lithuania
R1	B2	■			■	■	■	
R2	B1	■	■	■	■	■	■	■
R3	B1,B2	■	■	■	■	■	■	■
R4	B1,B2	■				■	■	■
R5	B1,B2			■		■		■
R6	B2	■						
R7	B2	■		■	■	■		

B1 = Insufficient market signals for some stakeholders;
B2 = Uneven frameworks for different renewable energy resources

- All foresee an increase in VRE
- Common barriers, but specific conditions need consideration
- All have information deficit on flexibility and lacking policy awareness



Summary and next steps

Flex4RES

Transition to a 100% RES-based Nordic energy system is possible

- **Present system already relative flexible**
- **Policy awareness on flexibility** in addition to traditional environmental and cost related issues.
- **System** instead of individual sector approaches
- **Soft infrastructure** (Regulation/economics/institutions) as important as hard infrastructure
- Develop adequate **incentives**

Next steps / research questions

- Impact assessments/quantification
- Low hanging fruits / socio-economic least-costs solutions
- Technology and climate/environmental impact
- Pathways - Regulatory, technical and sustainable
- Policy recommendations

Questions?

Klaus Skytte
Head of Energy Economics and Regulation
DTU, Denmark
klsk@dtu.dk

www.Flex4RES.org

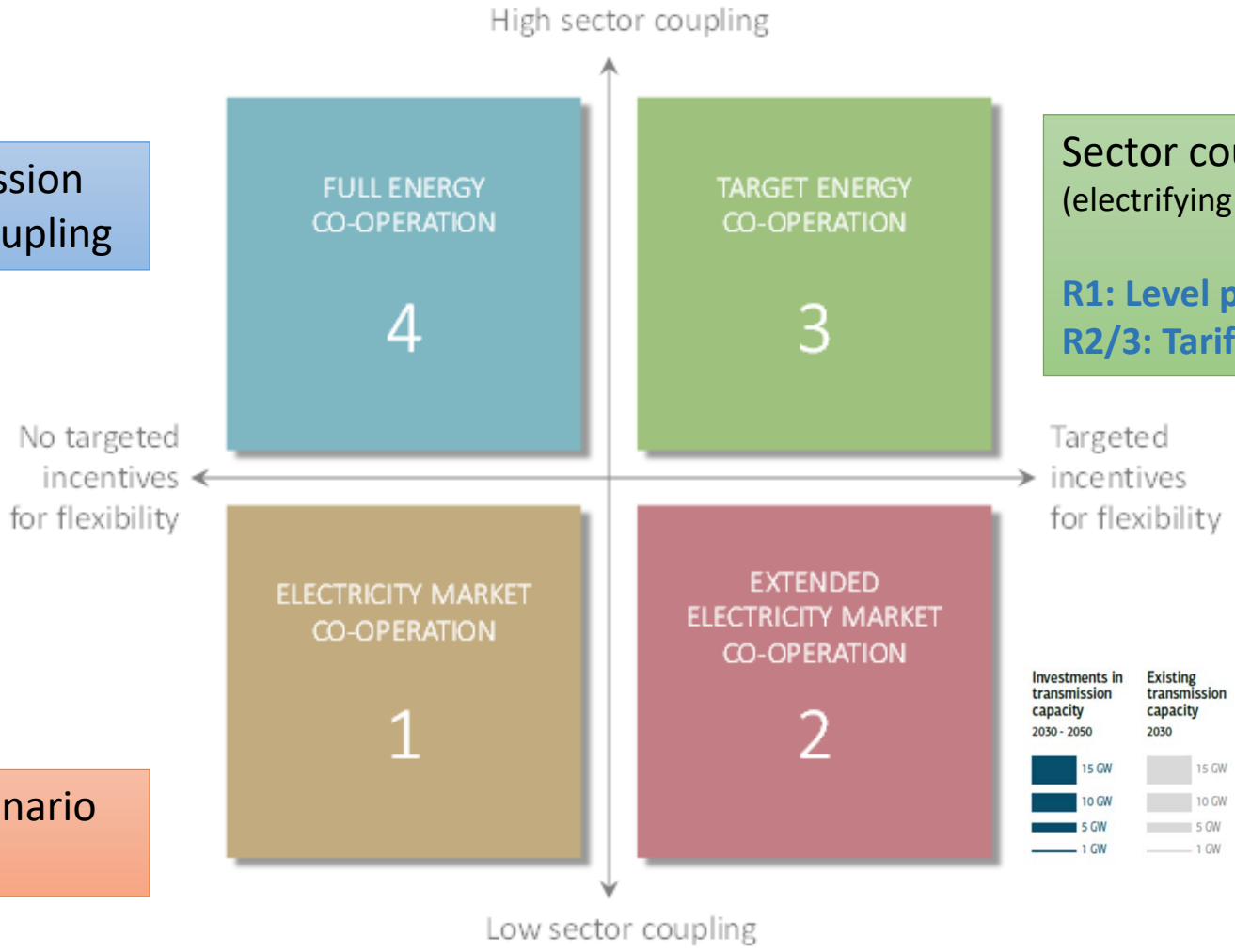
Extra slides

Scenarios

Flex4RES

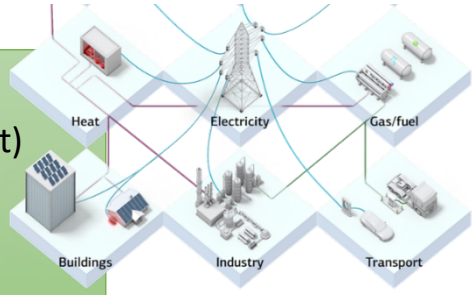
Both transmission and sector coupling

Reference scenario BAU

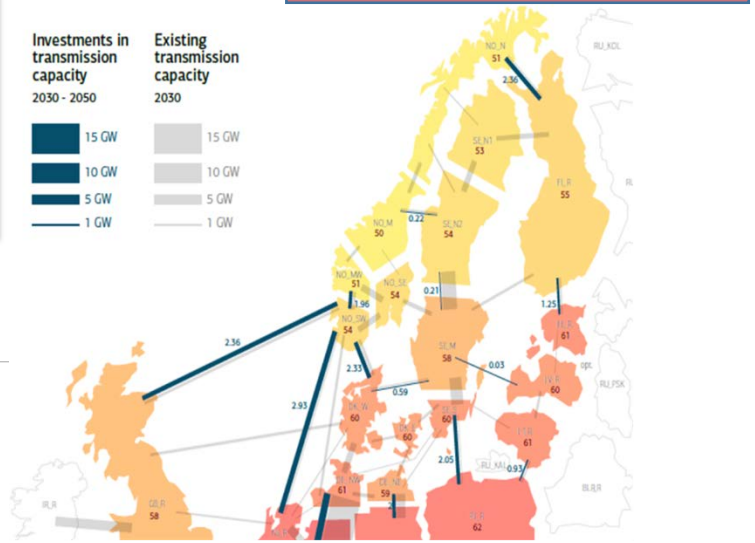


Sector coupling
(electrifying heat, gas, transport)

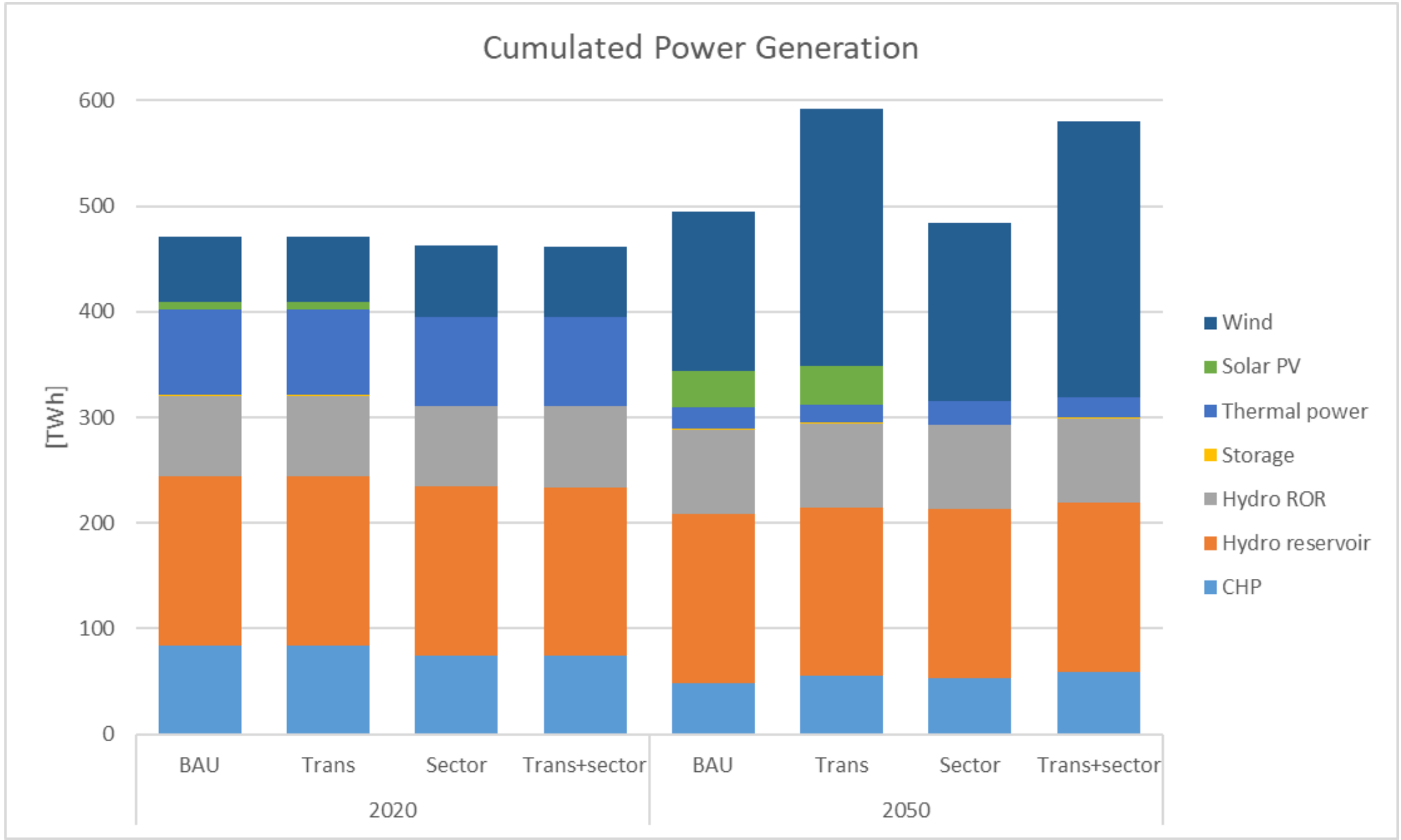
R1: Level playing field
R2/3: Tariffs & taxes



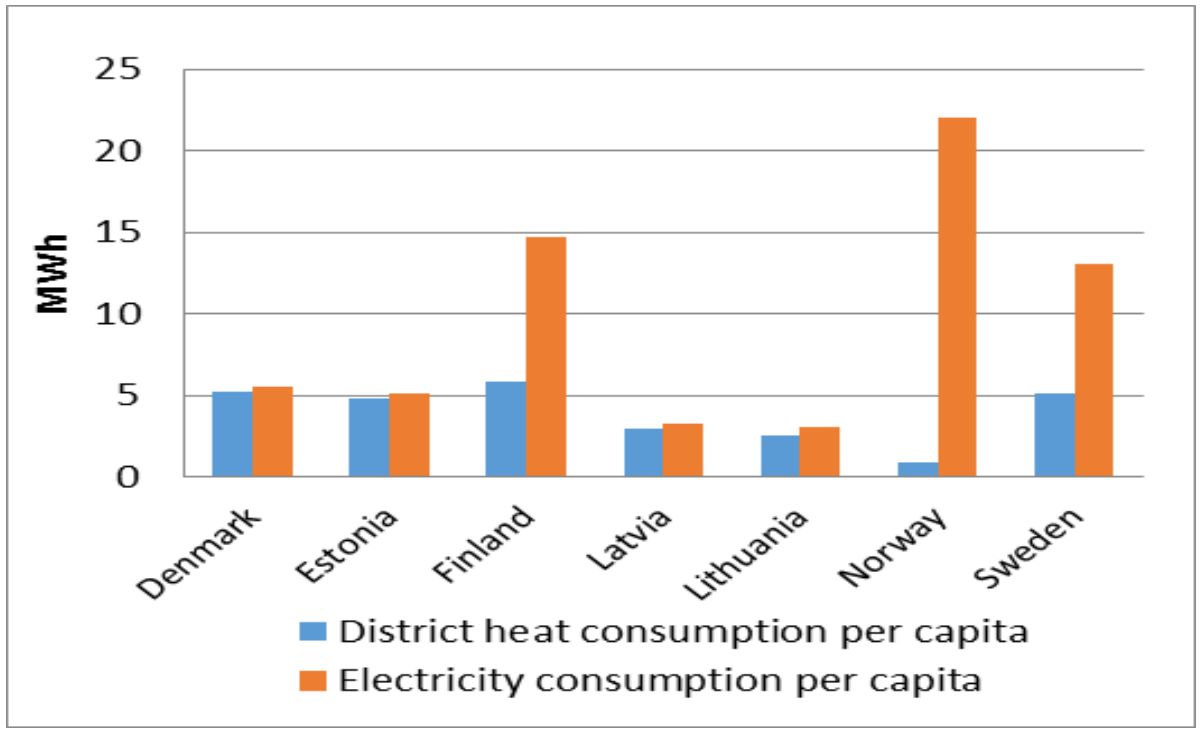
Interconnection

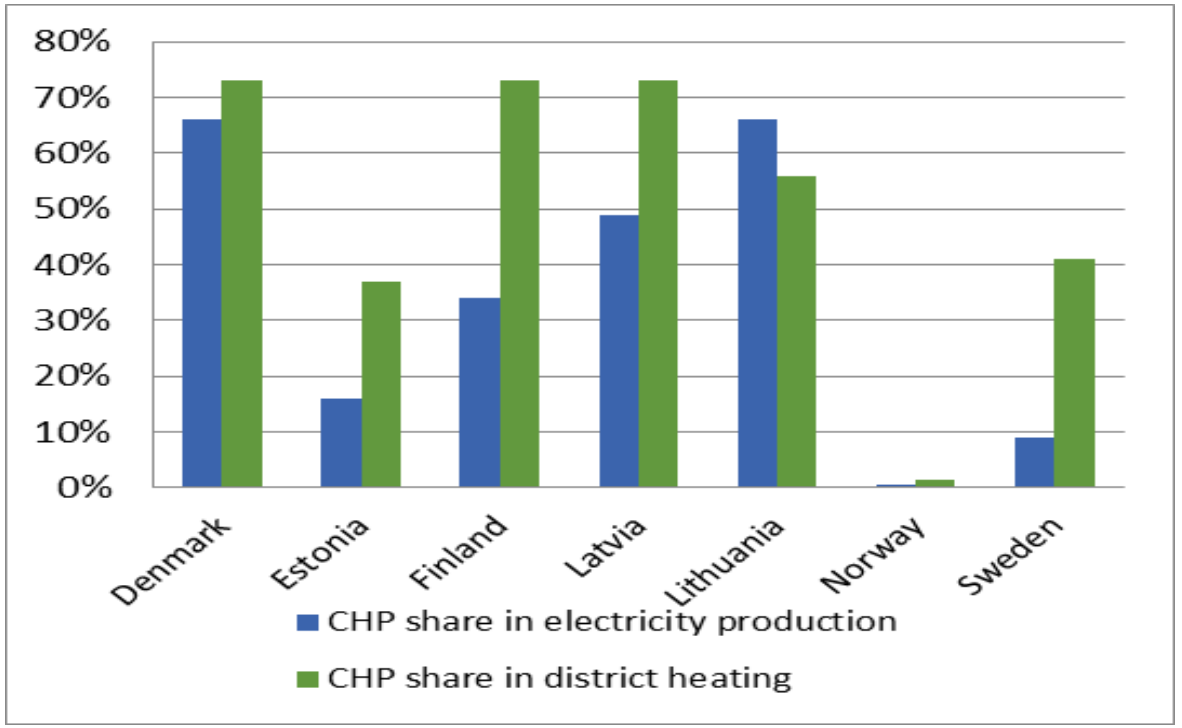


Scenario / model runs



District Heating in the Baltics/Nordics

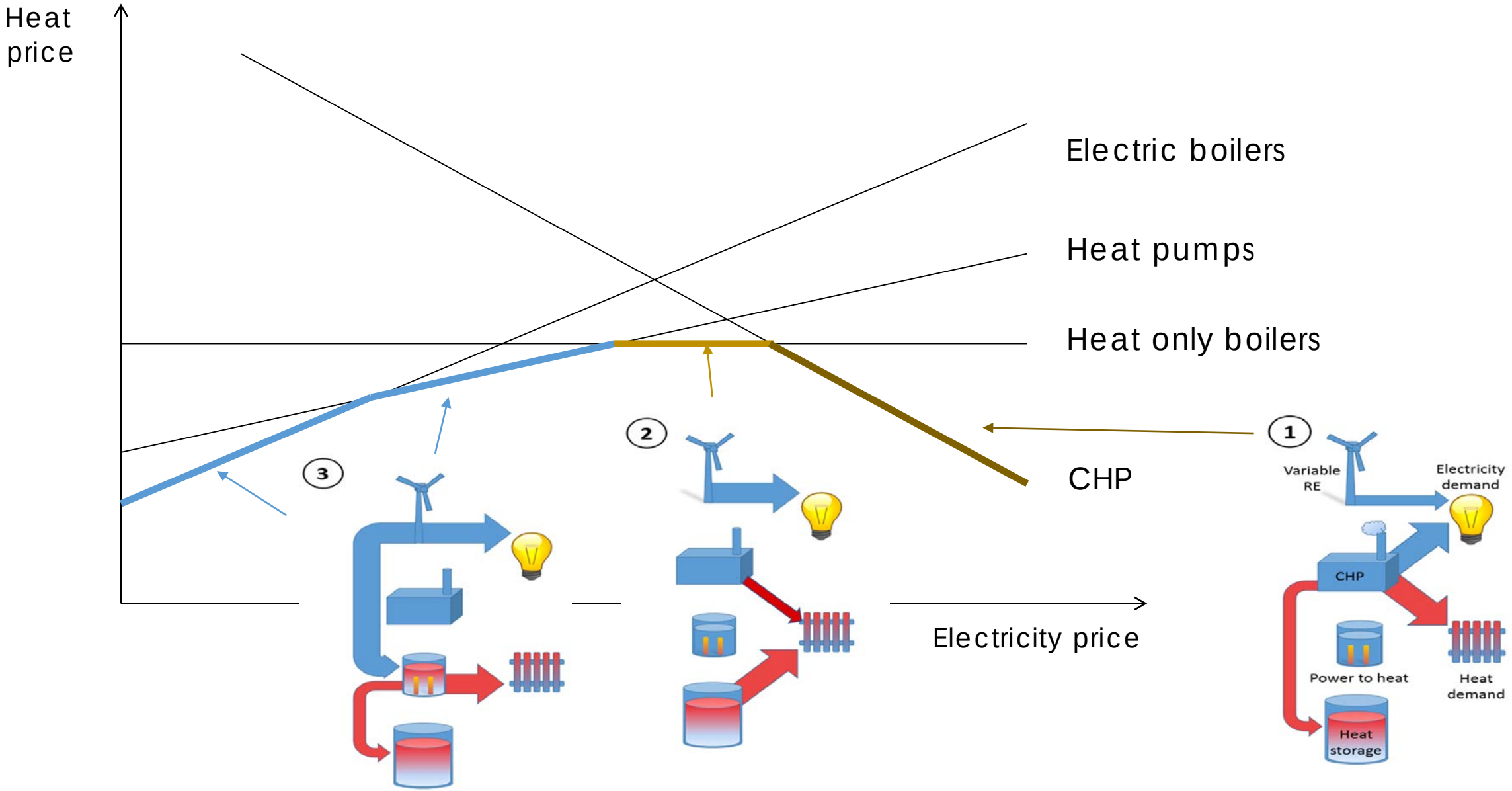




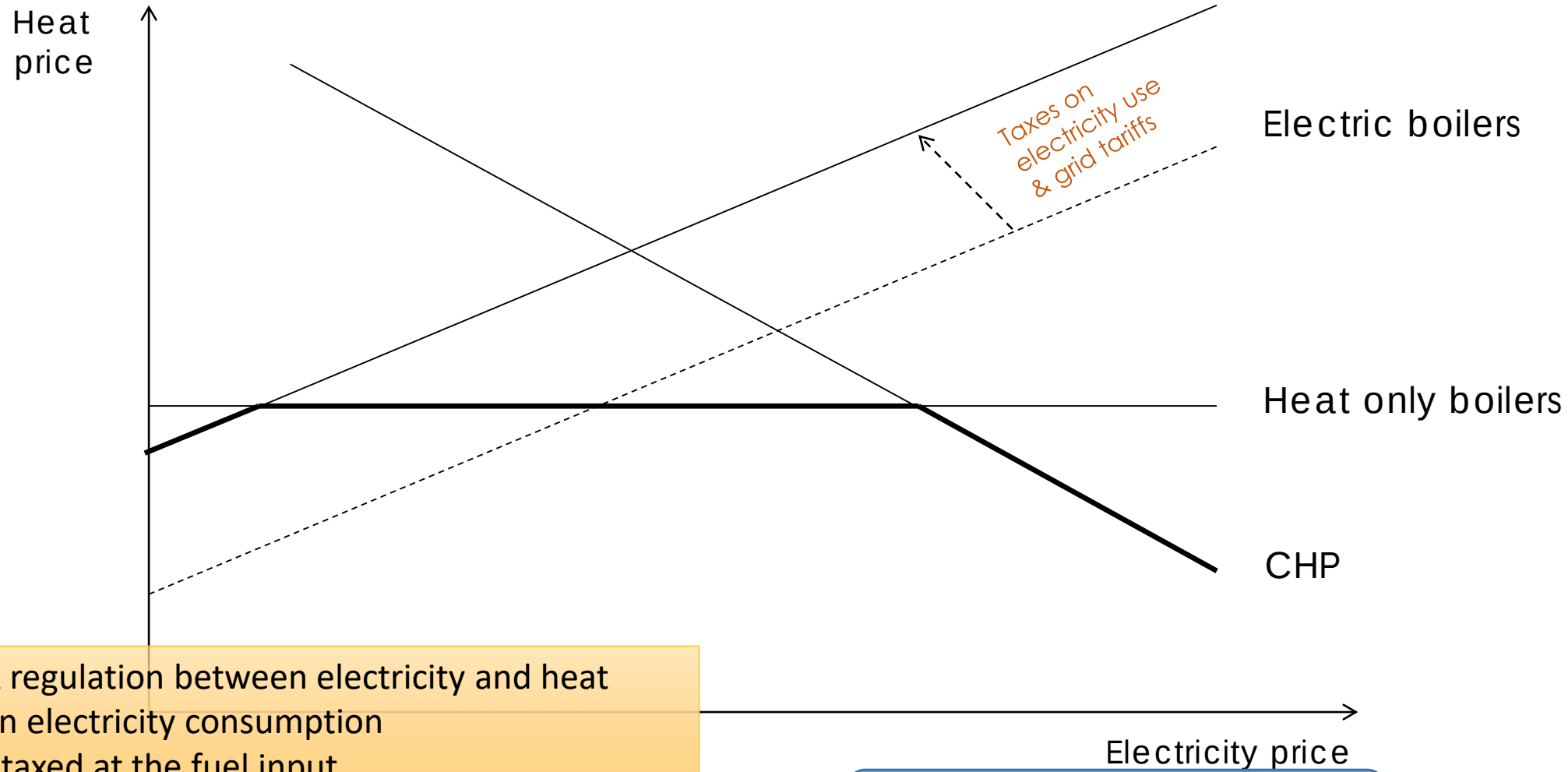
Source: Euroheat, 2015

District heating is widely used in most Baltic/Nordic countries and thus represents a flexibility source of considerable magnitude which is only partly exploited today by the power market

District heating-electricity interface



Choice of heat supply - at different electricity prices



Patchwork regulation between electricity and heat

- Taxes on electricity consumption
- Heat is taxed at the fuel input
- Biomass exempted for taxes

More heat only boilers.
Decoupling of electricity and heat markets